THE VALUE OF FUEL MANAGEMENT IN REDUCING WILDFIRE DAMAGE

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ABSTRACT

The objective of this study was to test the effectiveness of a regular prescribed burning program to reduce mortality of southern pines when forests are burned by wildfire. The study was installed on the Osceola National Forest where about 10,000 ha of flatwoods forest type was burned by arson set wildfires under extreme conditions in June 1998. Stands within the burn area were divided by origin as either natural or planted. Tree mortality data summarized by plot were compared using analyses of variance in an unbalanced design to test for differences in pre-fire fuel treatments, site type, location and fire type. In natural stands, mean mortality was 32 percent. Burn history significantly effected mortality with those burned 1.5 years ago having about 15% mortality and those stands prescribed burned 2 years or more ago having tree mortality of 44 percent. Site type also significantly influenced tree mortality. On dry and moist sites 20% of the pines died, whereas the wildfire killed 54% of the trees on wet plots. Burn history had similar effects in planted stands where tree mortality was 5% in stands burned 1.5 years previously and 52% for those that had been accumulating fuel for 2 or more years. Plantations on the interior of the burn had 41% tree mortality while those near the perimeter had only 17% tree death. Although significant tree mortality did occur on the Osceola National Forest with some stands killed totally, not all of the trees in the burned area were lost. Thus, it does appear that a regular prescribed burning program will reduce mortality following wildfires in both natural and planted stands of southern pines on flatwoods sites even under severe drought conditions.

Keywords: prescribed burning, wildfire, longleaf pine, slash pine, mortality

INTRODUCTION

In the South, as elsewhere, fuels accumulate with time, until equilibrium is reached with decomposition. Fuel buildup since the last disturbance has been documented in the palmetto / gallberry fuel complex (Sackett 1975, McNab et al. 1978). For decades frequent, regular prescribed burns have been used to reduce these fuel loads. The judicious use of prescribed burning has been promoted to reduce the area burned by uncontrolled wildfire. It has been widely assumed therefore, that wildfires would be kept small and damages limited. Davis and Cooper (1963) showed a strong relationship between the acres burned in wildfires and the time since the last prescribed burn for sites in North Florida and South Georgia. They also found that height of bark char, a measure of fire intensity, was related to the age of the rough, i.e., years of fuel accumulation. Ferguson (1998) presented an overview of prescribed fire and its affects on wildfire size, suppression costs and resource damage on the Apalachicola National Forest in Florida. Martin (1988) indicated fire intensity during the Florida wildfires of 1985 was lower on areas previously prescribe-burned.

As noted by DeBano et al. (1998), there is a general trend of increasing fuel buildup and therefore fire severity with an increase in fire-return interval. Thus, there exists an implied relationship between overstory tree mortality and time since the last burn. Mortality can result from high-intensity crown-consuming fires or from high-severity ground fires consuming accumulated litter around the base of trees (Ferguson et al. 1960). For some species, mortality is closely related to crown damage (Cooper and Altobellis 1969, Finney and Martin 1993, Ryan et al. 1998). Mortality in other species seems to be more closely related to bole injury (Peterson et al. 1991). A review of this topic can be found in Wade and Johansen (1986). Most recent research in the South has concentrated on injury and growth following prescribed burns (Boyer 1987, Johansen and Wade 1987, Lilieholm and Shih-Chang 1987).

Little information exists, however, on tree mortality following wildfires in areas where fuels are routinely reduced through prescribed burning. The primary objective of this study was to determine the effects of fuel management through prescribed burning on wildfire severity as measured by overstory damage. The null hypothesis was that during severe drought, conditions are so extreme that pre-wildfire fuel treatments have no effect on fire severity or overstory mortality. A secondary objective was to determine if overstory mortality is related to stand origin, i.e., natural versus planted, or site type.

METHODS

The study site was on the Osceola National Forest where wildfire burned about 10,000 ha of flatwoods forest type under extreme conditions during June 1998. On June 3, when this arson fire was set at 6 to 8 locations the drought index was over 700. The wildfire burned 325 ha the first day and by the third day was 600 ha in size. From June 5th to the 17th the fire was contained but could not be extinguished because it was burning in organic layers in the normally wet depression areas. On the 19th, the wildfire made some new runs and it broke loose the following day. The drought index on June 20th was over 750, the relative humidity was down to 35% and the temperature was over 32 °C. During the next 4 days, the wildfire burned 7200 ha under these extreme conditions.

All pine stands within the burn area were divided by origin into natural or planted categories. Natural stands were a mixture of slash (*Pinus elliottii*) and longleaf pine (*P. palustris*) and plantations were slash pine. Within each of these two types, 21 stands were randomly selected for sampling. Selected stands were sampled from November 1998 to February 1999. Within each stand, five circular plots were located 30 m apart along a line transect with a randomly selected starting point. Plot size varied with tree density from 0.01 to 0.05 ha so 15 to 20 trees were sampled per plot. When the dominant tree height was greater than 15 m, all pines with a diameter greater than 5 cm were measured. For selected stands with dominant trees less than 15 m tall, all pine trees taller than 1.37 m were measured. For each sample tree in the circular plot, the species, diameter, condition (live or dead), crown death (%), and bole char (%) were recorded. Crown death was due to a combination of direct mortality caused by the fire and indirect death of needles resulting from bark beetle attacks. At each plot, the site type (dry, moist or wet) and location relative to the burn (interior or edge) were noted. The fire history (time since last prescribed burn) and fire type (heading or backing) were obtained from records of Osceola Ranger District. Tree mortality data were compared using analyses of variance.

RESULTS

Trees in natural stands were mostly pole and saw timber sized. The average diameter for sample trees in natural stands was of 24.4 cm. Mean height for dominants and co-dominates was 26 m. Plantations ranged in age from 8 to 35 years. Average tree diameter in plantations was 14.4 cm and mean height was 16.0 m. Eight of the 21 plantations sampled had mean heights less than 15 m. All natural stands and plantations with trees over 15 m tall had been thinned at least once prior to the wildfire.

Fire intensity and therefore tree mortality covered a broad range. In some stands, the wildfire totally consumed most crowns, directly killing the trees. In other stands, trees were stressed and many later succumbed to insect attacks over the following summer and fall, while others had little apparent damage and only a few dead trees. Overall, mortality was higher in plantations (39%) than it was in natural stands (32%). Average tree mortality in both natural and planted stands was lowest in stands that had been prescribe-burned 1.5 years prior to the wildfire (Figure 1). Mortality was higher for those areas burned within 6 months of the wildfire and for those burned 2 or more years ago

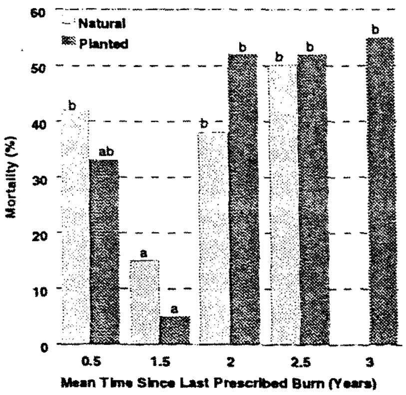

Figure 1. Tree mortality from June, 1998 wildfire in natural and planted stands of pine on Osceola National Forest, Florida. Letters denote significant differences at 0.05 level.

Relative moisture level of the area influenced tree mortality within natural stands where losses were significantly higher on the wetter areas (Table 1). There were no plantations on the wettest sites and no difference in tree mortality between dry and moist areas. Natural stands on the edge of the wildfire and those in the interior showed no difference in average tree mortality. In plantations, however, mortality was much lower for those trees near the edge of the burn. There were no significant differences in tree mortality between areas burned by heading fires and those burned by backing fires.

	Survival (%)	
	Natural Stands	Planted Stands
Site Type		
Dry	16a*	26a
Moist	26a	32a
Wet	54b	
Location		
Edge	34a	17a
Interior	30a	41b
Fire Type		
Backing	29a	19a
Heading	35a	39a

Table 1. Average survival of overstory pines by site moisture level, location, and fire type following wildfire on Osceola National Forest, Florida.
*Within a column, for each section, means not followed by the same letter are significantly different at the .05 level.

DISCUSSION

Time since the last prescribed burn did influence tree mortality. The lowest mean tree mortality occurred on those areas that had not yet accumulated much fuel. Those stands burned 1.5 years prior to the wildfire had the lowest mortality (they had only one full growing season since the last burn). Although the stands burned just before the wildfire had not accumulated much new fuel, trees also did not have much time to recover from the stress of the prescribed burn. Most of these stands had been burned in February, just 3 months before the wildfire. We believe the combined stress of the prescribed burn and the wildfire in a short period of time caused an increase in tree mortality.

The accumulation of understory and forest floor fuels in longleaf and slash pine stands is very rapid during the first 10 years following a prescribed burn (McNab et al. 1978). Overstory feeder roots began colonizing these decomposing fuels within a few years. Fires that burn under recommended prescribed burn weather conditions do not consume all of this fuel. During severe drought and burning conditions, however, consumption of the understory and forest floor is virtually complete. Thus, it is not surprising that mortality levels increased significantly in those stands that had not been burned for two or more years. The increased mortality on wet sites was also fuel related. Prescribed burning normally creates a mosaic burn pattern in these flatwoods types, as it rarely enters the wetter depressions. Even when these area do burn, it is a light surface burn that consumes only a portion of the understory, because the forest floor is too wet to burn. Under extreme drought conditions such as existed during the wildfire, however, both coverage and consumption of forest floor and understory are nearly complete, resulting in high tree mortality. Fuel differences may be the cause of lower mortality in plantations on the perimeter of the burn as well. Those plantations on the edge of the area burned by the wildfire were mostly quite young and had a grassy dominated understory. Many of the interior plantations were older and had understories dominated by saw palmetto (*Serenoa repens*) and gallberry (*Ilex glabra*). This difference in understory did not exist in natural stands, which had equal tree mortality levels at both interior and edge locations.

Headfires should produce greater intensities, but backing fires because of their increased residence time can be expected to cause greater cambial heating near the ground (Lindenmuth and Byram 1948) although the actual situation is not so clear cut (Wade and Johansen 1986). The stands sampled in this study burned by headfire had on average greater initial crown damage, while many of those burned with a backing fire had essentially no crown scorch. Trees in those stands burned with a backing fire had healthy looking green crowns for a number of weeks following the wildfire. However, on areas with a 2-year or greater rough, they experienced substantial bark beetle attack and subsequent mortality during the late summer and fall. Thus, there was no significant difference in mean tree mortality by fire type, even though the nature of the injury differed between the fire types.

Although significant tree mortality did occur on the Osceola National Forest with some stands killed totally, not all of the trees in the burned area died even though the wildfire occurred under quite extreme conditions. No areas in any sample stands were left unburned, so this was not a case of random areas escaping the wildfire. Overall losses averaged less than 40 percent; but was this the result of prescribed burning or just because the trees are able to recover from severe fires? In the New Jersey pine barrens, Moore et al. (1955) reported tree mortality following a wildfire was 64% in previously unburned areas but only 17% in areas prescribed burned during the preceding 3 years. Prescribed burning provided similar reductions in tree damage following wildfire under extremely dry conditions in the same area of New Jersey (Cumming 1964) and in the ponderosa pine type in Arizona (Wagle and Eakle 1979). Under severe drought conditions, that occur every 10 to 20 years, mortality of southern pines on areas with 5 or more years of fuel accumulation is very high (Eldredge 1935). Those few trees that do survive the immediate effects of these wildfires are usually killed by subsequent bark beetle attacks. Bickford and Bull (1935) reported near total pine mortality for such a wildfire in stands protected from all burning for 16 years. The 39% loss in plantations and 32% in natural stands for our study were quite low by comparison. The increase in mortality with time since the last burn found also indicates that prescribed burning can reduce timber loss. The wet sites in our study where fuels accumulate because they normally do not burn during prescription burns, can be used as a type of non-burned control. The mortality rate was twice as high on these sites as on the moist sites where prescribed burning had kept fuel loads down. It does appear that a regular prescribed burning program will not only reduce the size of wildfires but will also reduce tree mortality if a wildfire does burn through the area. This reduction in tree mortality occurs in both natural and planted stands of southern pines on flatwoods sites, even with wildfires under extreme drought conditions.

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